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THE WORKABILITY AND COMPRESSIVE STRENGTH OF CONCRETE USING TEXTILE MILL SLUDGE AND PLASTICIZER

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ABSTRACT

Growing population and life quality, both lead to higher consumption of resources. High rate of consumption of resources generate a lot of waste material. Improper management of waste material causes various environmental problems. Textile Industries play an important role in the economy of a nation, but on the other hand it generates a lot of waste material through various processes. The waste produced by textile industry is known as Textile Mill Sludge (TMS) from Effluent Treatment Plant (ETP). This sludge is very hazardous in nature and causes various negative impacts on our Environment. In the present study, attempts are made to find an alternative way to reuse this sludge waste rather than dispose it into landfills. It will help us to find an eco-friendly material and another possible solution of sludge management. In this study, the workability and compressive strength of concrete with various percentages are found. Testing of all the materials was done according to the Bureau of Indian Standards. Fine aggregates were replaced with TMS in various percentages in M20 grade concrete and plasticizer was used 1% @ by weight of cement. Experiments were conducted to find the workability and compressive strength of concrete. It is concluded that the increase in quantity of Textile Sludge causes reduction in strength properties and workability of concrete. When fine aggregates were replaced by Textile Mill Sludge beyond 35% along with an estimated quantity of plasticizer in concrete, the compressive strength and workability decreases. The utilization of Textile Mill Sludge of concrete as a substitute will helps us to reduce negative impacts of sludge waste and its safe disposal to save our Environment.

KEYWORDS: Workability, Compressive Strength, Textile Mill Sludge, Plasticizer, Concrete Materials & Slude Management

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Original Article

INTRODUCTION

A speedy growth of urbanization and industrialization causes various environmental problems due to improper management of waste materials. Textile Industries are one of the oldest Industries in India, which plays an important role in framing our economy. A large amount of revenue is being generated from textile exports, but on the other hand textile industry affects our environment by producing a large quantity of waste materials both liquids and solids. The production of cloths in textile industries is done by various processes, which consumes large quantities of water and results in production of highly polluting waste effluent. Desizing, bleaching and dyeing are major wet processes which results in producing an equal amount of discharge containing dyestuffs or chemicals etc. This waste water again disposed to Effluent Treatment Plants (ETP) for its further treatments. In ETP, the water was treated using some chemicals to make it clean, pollutant free and for its safe disposal. There are the chemicals like Alum, Lime, Ferric chloride, Polyelectrolyte etc. are used to clean waste water and results in generating sludge,

known as Textile Mill Sludge (TMS) from dyeing ETP. As the waste water is treated using chemicals, then the resultant Sludge (solid waste) will definitely contain some chemical properties. The improper disposal of textile sludge in landfills causes various negative impacts (harmful) to our environment. Therefore, it is very important to discover alternative solutions for the management of textile mill sludge. Many researches have been done and some are going on the utilization of textile mill sludge in constructional materials for both structural and non-structural purposes. So, at the end there is a growing requirement to investigate various other possibilities for reuse, this textile waste and how to preserve our environment for sustainable development. The main objective of this study is to find an alternative to reuse the textile sludge rather than to dispose it into landfills. Attempts have been made to reuse the textile sludge in concrete and to find its influence on compressive and workability of concrete.

MATERIALS AND METHODS

First of all, the quantities of required raw materials, cement, sand, aggregates and water were determined from concrete mix design according to the IS 10262-2009. The *Table 1* shows the measured quantities of materials.

Table 1

Cement	Fine Aggregates	Coarse Aggregates	Water
334 kg/ m^3	785.90 kg/ m^3	1156.64 kg/ m^3	186 liters/m^3
1	2.353	3.462	0.50

Cement: Ordinary Portland Cement (OPC) which is mainly of three grades 33, 43 and 53 grades depending upon the compressive strength of cement at 28 days. In this study OPC 43 grade was used. It was totally free from lumps and carefully stored to protect from moisture content. The *Table 2* shows the physical properties of OPC 43 cement, According BIS: 8112-2013 to which were determined in material testing laboratory, PAU, Ludhiana.

Table 2

Sr. No.	Characteristics	Value Obtained Experimentally
1.	Specific Gravity	3.17
2.	Standard consistency	31%
3.	Initial Setting time	146 minutes
4.	Final Setting time	244 minutes
5.	Compressive Strength 3 days 7 days 28 days	 24.60 N/mm^2 35.87 N/mm^2 48.45 N/mm^2

Fine Aggregates: Locally available fine aggregates (sand) were used in this study. Sand passing through a sieve 4.75 mm and conforming to Grading zone II of IS: 383 –1970 was used for casting of all the specimens. The sand was tested as per IS 2386. The fineness modulus of sand was 2.73 with specific gravity 2.55.

Course Aggregates: The coarse aggregates used in this study were a mixture of two locally available crushed stone of 10 mm and 20 mm size in 50:50 proportions. The aggregates were washed to remove dirt, dust and then dried to surface dry condition. The physical Properties of coarse aggregates like Fineness Modulus, Specific Gravity are 8.22, 2.67 respectively.

Water: As per IS 456- 2000 Potable water is considered satisfactory for mixing and curing of concrete. Accordingly, potable tap water was used for the preparation of all concrete specimens. It should be free from oils, acids, salts and organic substances. The pH value shall not be less than 6.

Textile Mill Sludge: The sludge which was used in this study collected from various textile mills at Focal Point in Ludhiana, Punjab. The wet Sludge was collected directly from drying beds by random sampling in plastic bag.

Figure 1: Textile Sludge in Wet State

Figure 2: Dried Textile Sludge

Each bag contains 20 kg of sludge. The collected sludge had near about 30-35% of moisture content. So, Sludge was dried in direct sunlight for making it moisture free and then grinding was done using manual methods with trowel and hammer. There were some problems while handling sludge as it had low density and it was blown away with movement of air. Thus care should be taken while drying and grinding it. The physical properties of textile sludge were determined in material testing laboratory, College of Agricultural Engineering and Technology, PAU, Ludhiana. The properties are shown in *Table 3***:**

Table 3

Sr. No	Parameter	Result
1	pH	7.82
2	Electrical conductivity	0.37
3	Specific gravity	1.93
4	Moisture content	30-35%
5	Color	Depends upon dyeing color.

Plasticizer: Plasticizer name "Conplast SP430 G8" based on Sulphonated Napthalene Polymers, Plasticizer is shown in Figure 3 was used in this study complies with IS:9103:1999 and BS:5075 Part3. Conplast SP430 G8 was brown liquid in color and was instantly dispersible in water. It was mainly used to produce high quality concrete of reduced permeability. The specific gravity of this plasticizer varies from 1.24 to 1.26 and had no Chloride content. In this study the dosage of plasticizer was kept 1%@weight of cement used.

Figure 3: Plasticizer

METHODOLOGY

Workability and Compressive Strength: Testing for Workability and compressive strength of concrete were conducted in this study. The workability of concrete comes under the category of fresh concrete properties. There were mainly the following two methods were used to check the workability of concrete one is a Slump Cone Test and other is Compaction Factor Test. The compressive strength of concrete is one of the mechanical properties of hardened concrete. In this experimental program, to determine workability and compressive strength of concrete, total six mixes were prepared using different replacements of Fine aggregates with Textile Sludge. The water to cement ratio was kept 0.50. Each calculated quantity of raw materials was weighed separately. Firstly, the fine aggregates and TMS were uniformly mixed in a dry state than cement and coarse aggregates were mixed to get uniform distribution. Water after mixing with a measured quantity of plasticizer was added to the mix and then all the ingredients were mixed thoroughly for 3 to 4 minutes. Compressive strength of concrete was determined from cubes of 150 mm × 150 mm × 150 mm in size. Firstly the Cube molds were cleaned and then oiling was done. After the preparation of molds the concrete was filled into the cube molds. Concrete molds were vibrated to ensure proper compaction,. Trowel was used for surface finishing. The finished specimens were left for 24 hours. The specimens were removed from the molds after 24 hours of casting and were placed in the water tank, filled with potable water in the laboratory as shown in figure 4. In this study total fifty four (54) Specimens were prepared by varying the percentage of textile sludge. Specimens were taken out from the curing tank at the ages of 7, 14 and 28 days. The specimens were immediately tested after removal of the curing tank. The compressive strength of concrete cubes was tested under Universal Testing Machine (UTM) as shown in *Figure 4 and 5*.

Figure 4: Curing of Samples

Figure 5: Testing of Sample on UTM

Table 4: Designation of Concrete Mix

Mix	Plasticizer	%Age of Textile Sludge	%Age of Fine Aggregates
G0	1 % @of weight of cement used	0	100
G1		15	85
G2		25	75
G3		35	65
G4		45	55
G5		55	45

RESULTS AND DISCUSSIONS

Workability of Concrete: The workability of concrete is one of the properties of fresh concrete or mortar used to determine the homogeneity and the ease with which concrete can flow. It helps to determine the internal work required to concrete without segregation and bleeding of concrete. The workability of concrete depends upon various factors such as properties of raw materials, amount, humidity of the environment and method of placement of concrete, etc. The workability of concrete in all mixes was measured by using two different methods, Slump cone test and Compaction factor test, according to IS: 1199-1959.

Slump Cone Test: Slump cone test is mostly used method to measure the consistency of concrete. The apparatus used for this test is consisting of metallic mold known as slump cone and Tamping rod.

Compacting Factor Test: Compacting factor test for the workability of fresh concrete is more precise. This method is very useful for the mixes with low workability. The instrument with standard height with two hoppers and one brim used to conduct this test, by the fall of concrete from upper hopper to brim, the amount of work done can be calculated which is used to determine the degree of compaction. It is also known as compacting factor which is mainly depends upon the density ratio. The weight of partially and fully compacted concrete was noted. The Table 5 shows the workability results.

Table 5: Workability Test Results

%Age of Textile Sludge	Slump (mm)	Compaction Factor
0	95(medium)	0.890
15	90(medium)	0.873
25	80(medium)	0.879
35	70(medium)	0.813
45	50(low)	0.780
55	45(very low)	0.750

The Following Figure 6 shows the graphical representation of Slump values with an increase in percentage of textile sludge. From the obtained results it is concluded that the workability of concrete goes on decreasing beyond 35% replacement of Textile Sludge because there is no proper bonding between the materials. s

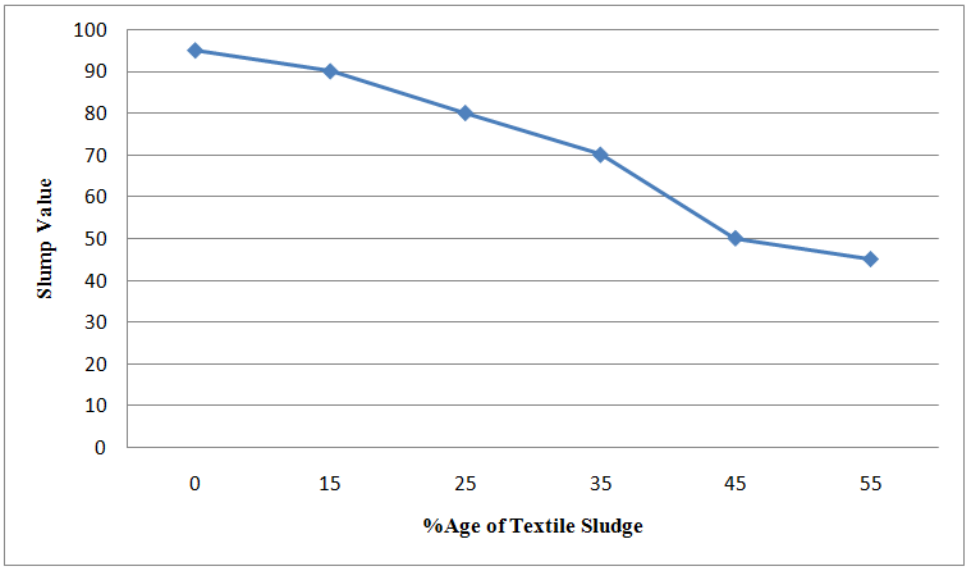

Figure 6: Workability of Concrete Mixes

Compressive Strength of Concrete

The strength of concrete helps us to determine the quality of concrete. The rejection and acceptance of concrete are mainly judged on the basis of its strength. In the present study the compressive strength of all the mixes was determined at the ages of 7, 14 and 28 days on 15 cm cube size for different replacements of fine aggregates with Textile Sludge and using Plasticizer 1%@ by weight of cement. The values of average compressive strength for different replacement of Textile Mill sludge (0%, 15%, 25%, 35%, 45% and 55%) at different curing periods (7, 14 and 28 days) are given in *Table 6.*

Table 6: Test Results for Compressive Strength of Concrete

Mixes	%age of Textile Sludge	Plasticizer	7 Days (N/mm^2)	14 Days (N/mm^2)	28 Days (N/mm^2)
G0	0	1% @wieght of cement used	13.06	18.35	25.16
G1	15		12.94	18.77	25.57
G2	25		11.71	18.82	25.90
G3	35		12.85	16.06	23.55
G4	45		4.14	8.78	12.11
G5	55		1.10	5.43	8.43

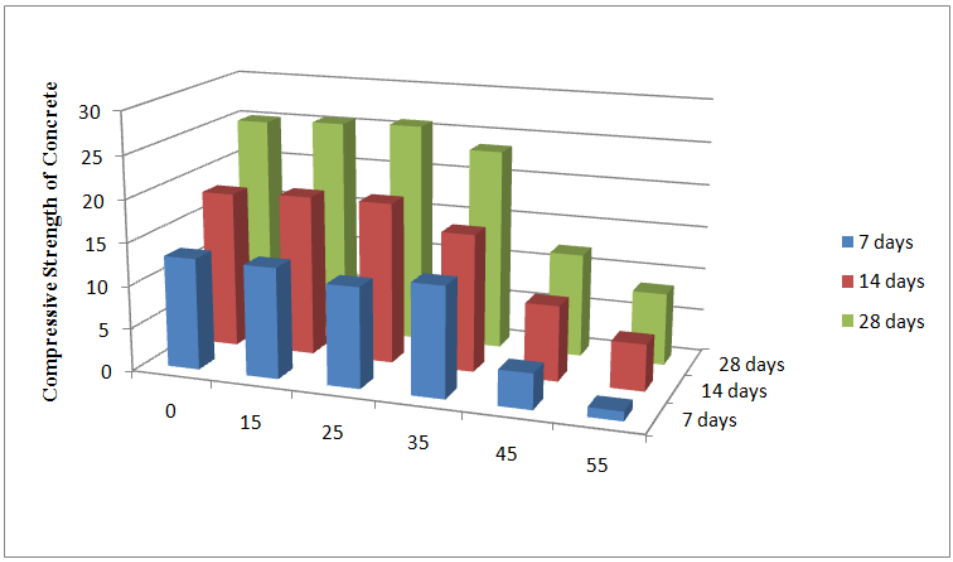

Figure 7: Compressive Strength of Concrete Mixes

CONCLUSIONS

- As we increase the quantity of Textile Mill Sludge in concrete, water requirement for mixing is more.
- The specific gravity of textile mill sludge is low as compare to fine aggregates.
- The optimum quantity of replacement of textile mill sludge with fine aggregates is 35%, which results 23.55 N/mm^2 compressive strengths for the M20. If the replacement quantity increases beyond 35%, then bonding problem is there.
- If we add 1% plasticizer by weight of cement, then there is no change on compressive strength and workability of concrete.
- Textile mill sludge is very hydroscopic in nature. There are lots of problems to handle this Sludge because of its Low density as compared to fine aggregates.

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